The Future of "Waste": Etymological and Conceptual Foundations of Solid Waste Management

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Executive Summary

This paper examines the diversity of goals and assumptions that shape how solid waste and the materials that eventually become it are understood and also attempts to clarify the role of source reduction within solid waste management. By exploring these paradigms, or "worldviews," we hope to explain why different groups arrive at different conclusions. The project's instruction is that the current, predominant approaches to solid waste management are not conducive to source reduction, and that to facilitate substantial source reduction we need to cast the net wider.

We began by identifying four approaches to the issue of solid waste management, the <u>Dominant Paradigm</u>, the <u>Discard Separation Paradigm</u>, the <u>Value in Use Paradigm</u>, and the <u>Material Flows Paradigm</u>. All focus on different aspects of our relationship to the materials we take into our economy, modify, process, sell, consume, and then recycle, throw away, or (sometimes) reuse. We believe these approaches, or *paradigms*, cover all major views of solid waste presently held. By examining them, we were able to scrutinize the claims and arguments made by their adherents. We were particularly interested in the situations in which the mindset characteristic of one paradigm obscured an understanding of the other paradigms' goals and concerns.

We explored several ways of shedding light on this issue. One was to examine key terms within each paradigm. While some terms are shared, with meanings that enjoy broad agreement, others highlight the different emphases and priorities within each paradigm. Terms such as "waste," "disposal," "recycling," and "reuse," for example, are used to signify a wide variety of circumstances and activities. Similarly, the conditions under which a material is considered valuable differs from one paradigm to another. We also examined diagrams which express the central metaphor around which the paradigm is built. These reveal quite different structures.

These uses and representations point to differences in philosophy as well as in experience with wastes. By understanding how these differences came about, and tracing the development of key ideas, we hope to draw useful lessons and make recommendations, particularly with regard to the potential for source reduction and how to achieve it.

Source reduction enjoys varying levels of support within these paradigms, yet its potential has been neither well encouraged nor fully understood, compared to other, more familiar, strategies. We have therefore examined how source reduction might be more fully integrated within both practical and theoretical attempts to manage the flow of materials and the production of solid waste. In the process we distinguish between some of the claims about both its potential and its limitations.

An immediate practical result of this work could be guidance on terms and definitions that are commonly used with different meanings, helping to avoid the misunderstandings which presently interfere with communication and debate.

I. Introduction

The field of solid waste management is a heterogeneous landscape. The Dominant Paradigm advocates a pluralistic approach to disposing of solid waste. However, it does not do justice to other, more focused, efforts to creatively improve the ways we generate and dispose of solid waste. This project identifies four solid waste management paradigms, all of which take a different view of what the problem is and how to solve it. The four paradigms are concerned with successively earlier phases of material transformation, moving from questions of how best to get rid of unwanted "waste" (Dominant Paradigm), to options for more completely valuing "discards" (Discard Separation Paradigm), making better use of existing embodied value (Value in Use Paradigm), and redesigning production, products and processes up front for better system wide material efficiency (Material Flows Paradigm).

Both this diversity and the terms used within each of the paradigms are of primary interest to this project. Because key phrases and terms are used differently, their effective use is often compromised. Terms such as "waste," "disposal," "recycling," and "reuse," for example, are used to signify a wide variety of circumstances and activities. Their meanings are shaped by the goals and methods of each paradigm, which, as will be shown, can vary considerably. Similarly, the set of conditions under which a material (e.g., a discarded aluminum beverage can) is considered valuable changes from one paradigm to another. To some degree this confusion can be reigned in through a more judicious use of terms, but philosophical differences will remain.

A further concern addressed in this project is the present and future role of source reduction within solid waste management. Source reduction, as a method of curtailing the *production* of waste, is generally not well integrated within most of the frameworks examined here. An unfamiliarity with its demands seems to preclude any sincere and lasting attempt to implement it. The level of commitment to source reduction evidenced by the Dominant Paradigm is not adequate to bring about meaningful change in the way solid waste is produced.

To successfully integrate source reduction into a set of solid waste management policies (one of the main goals this project seeks to advance) the production of Municipal Solid Waste must first be appreciated as a complex social, cultural and economic phenomenon.[*] In conjunction with this, much greater emphasis must be placed on operationalizing the concept by drawing on ideas and strategies that speak directly to source reduction. Methods commonly held up as examples of source reduction evidence parallels to recycling, such as composting organic materials or food. This does not do justice to the concept of source reduction, and shows just how limited in scope the current approaches tend to be. "Product life extension" or "design for reparability" lie outside the Dominant Paradigm's range of source reduction methods, but they must be recognized and implemented in the solid waste management approach to source reduction if it is to be accorded the status its position in the *Integrated Waste Management Hierarchy* implies.

With a spectrum this broad, issues on which opinions differ outweigh those where agreement can be found. Nevertheless, some overlap is clearly evident between the paradigms' goals as well as in their methods. The approaches identified by the four paradigms do not yet constitute a complementary set of tools and guiding principles. However, this could be pursued if the various strengths and insights of each were understood to be complementary ways of tackling the core problems vexing the pursuit of effective solid waste management.

[*](Although they may be of similar magnitude, industrial, hazardous, and other types of waste are not discussed in this paper because they tend to differ in their characteristics from MSW.)

II. Paradigms Compared: A Table

	Dominant (DP)	Discard Separation (DSP)	Value in Use (VIUP)	Material Flows (MFP)
subject of interest or concern	MSW	Discards	Consumption	Industrial Design/Material Flows/Production
institutions/ actors involved	gov't, industry, MSW management, recyclers	municipalities, private sector, citizens	varying, depending on results of empirical research	manufacturers, designers, engineers
scale at which change is attempted	large: federal, state, regional--also household	medium: region, municipality	on both a large scale and at a local level ; household	large: industry-wide, national, global
preferred tools/methods	legislation, incentives, technical support	physical infrastructure, business plan, collection, resale	methods follow from empirical research, rather than vice-versa	LCA, DFE, DFR, systems analysis,
problem to be solved	ad hoc waste manage-ment; range of previous management options too limited	Dominant approach to waste management flawed; value lost due to system design, to the detriment of environment and community	consumption overlooked as waste management variable; overproduction	material inefficiencies pervade all stages of product life cycles; waste
goals/agenda	stretch landfill space, limit overall environ-mental damage, foster a pluralistic approach to waste management, please everyone	render landfills and incineration unnecessary, find highest and best use for discards, promote MRFs and community integration, increase recycling	increase consumption efficiency as means to reduce production level; rationale = environmental and economic benefits	"cradle to reincarnation," sustainability, high quality of life, beneficent interrelationship between industry and environment; zero waste
views on recycling	encourage recycling	encourage recycling as way of life	discourage worship of recycling	complete material recycling viewed as ideal to be pursued at all processing stages
views on source reduction	important, but actually not very promising, expected to contribute only marginally	reuse is source reduction	highest priority, worthy of more attention, high potential	implicit in all key Industrial Ecology concepts
theory<----->practice	theory central, implementation uneven, management hierarchy not followed in practice	mix of both, successful implemen-tation	theoretical, lack of empirical data; takes energy as the example	theoretical, practice involves institutional transformation and willingness to set new priorities
barriers to implementation	source reduction priority does not mesh with position in hierarchy, conflicting mandates	political unwillingness to change subsidies and disincentives; availability of commercial space	concept not well under-stood; no public commit-ment to goal of reducing level of production	persistently cheap raw materials, lackluster organizational commitment
what is seen from outside as contentious	because source reduction is thought to have only limited potential, its position within the hierarchy remains unclear	source reduction is not addressed squarely; feasibility of total recycling unclear	consumption efficiency, value and satisfaction all concepts not easily demystified; challenge to "growth economy"	zero waste appears an elusive goal (both materially and energetically); conflicting mandates
what is considered "waste"	not clear whether all MSW, or only what is incinerated or landfilled	whatever is incinerated or landfilled	all MSW	ideally nothing; category exists only because we have not figured out how to reintroduce materials into production effectively
key terms	reduce-reuse-recycle, Integrated W.M. Hierarchy, diversion	discard, waste (v), recycling	consumption, production, waste production	Industrial Ecology, LCA, zero waste, DFE
key sources or references	EPA: "Agenda for Action," John Schall: "Does the Solid Waste Management Hierarchy make Sense?"	Dan Knapp: "The Bay Area's Prospects For Total Recycling"	Bruce Nordman: "Celebrating Consumption," Walter Stahel: "The Utilization-Focused Service Economy"	SETAC: "Guidelines for LCA," T. Graedel & B. Allenby: "Industrial Ecology"

III. Paradigms: One Page Summaries

Dominant (Integrated Waste Management) Paradigm (DP)

The Integrated Waste Management Hierarchy, initially articulated by the U.S. EPA in the mid 1970s, forms the core of the dominant perspective on solid waste management today. In this view, the problem of shrinking landfill capacity and environmental risks of incineration are addressed through strategies designed to divert waste away from these destinations. The simplicity and vertical ranking of Source Reduction, Recycling & Composting, Incineration and Landfilling attempts to prioritize among these options. Recycling is emphasized, however source reduction is not given the priority its prominent position in the hierarchy suggests. The EPA takes a pluralist approach to the management of MSW, encouraging local governments and municipalities to find a set of policies that matches their particular situation. However, it does put forth a set of strategies for dealing with various situations and types of refuse that serve as a framework or template. As most source reduction is concerned with a phase of materials handling well in advance of the discarding stage, it is not surprising that those institutions charged with implementing (the other) waste handling options are at a loss when it comes to initiating or fostering source reduction. Consequently the kind of source reduction efforts put forth are usually limited to backyard composting, general appeals to reuse products, to buy in bulk and avoid excess packaging.

The focus of the dominant paradigm is how to deal more comprehensively with both the quantity and composition of MSW. As such, efforts to improve the management of waste draw more heavily on an understanding of the physical and technical characteristics of waste management than on social or economic aspects of this issue. The solution to the "crisis of capacity and cost" lies above all in increasing the efficiency of waste handling processes to the point where recycling, landfilling and incineration become complementary features of a multi-level management system. The degree to which material flows--ultimately waste flows--are reduced hinges upon the success of incorporating strategies for changing economic and social patterns that presently thwart effective source reduction.

Figure 1a expresses the peaceful coexistence of the four major strategies. From EPA, The Solid Waste Dilemma, p. 17.

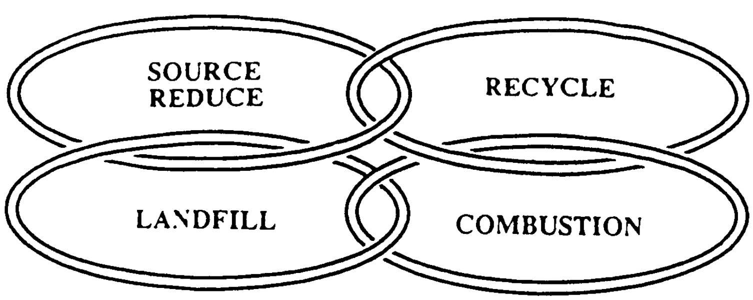
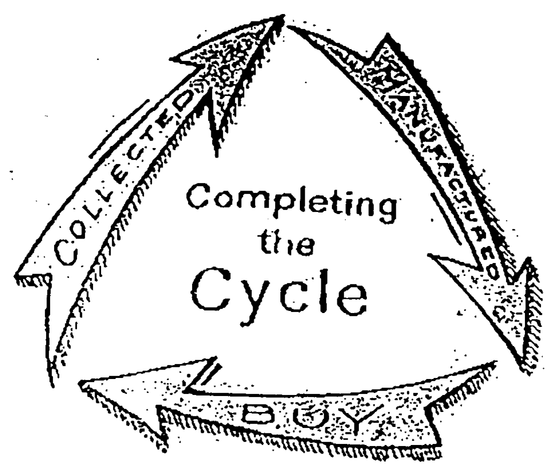


Figure 1b expresses the dominance of the idea of continuous circulation. From NRC, -------



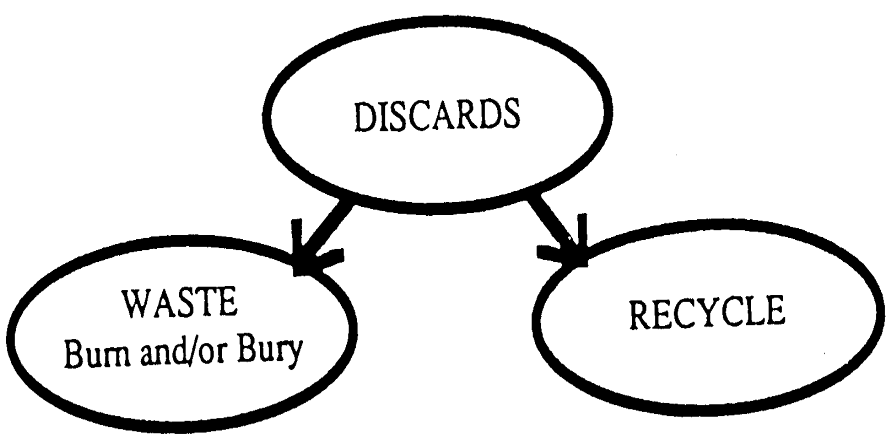
Discard Separation Paradigm (DSP)

A very different perspective is put forth by a number of community level organizations, whose efforts are in part a response to the Integrated Waste Management Paradigm, which is viewed as legitimizing landfilling and incineration, both of which are considered unacceptable "solutions" to the problem by adherents of this paradigm. Their view of managing discards relies on collection and source separation, repair, resale, reuse, and/or resource recovery at both the product and material level. Those products and materials society no longer wants are sorted into recycling and repair/reuse categories and then resold to scrap dealers and a segment of the public that appreciates the benefits of reuse. The intent is to drastically reduce the flow of waste heading for incineration or the landfill. The term "Zero Waste" is frequently used to describe the goal of this strategy. By seeking out the highest and best use for a given material or product, the potential economic gains greatly increase the chances of such a system to pay its own way, if not turn a profit. Social and environmental concerns are invoked as corroborating evidence that a different approach to discard management is needed.

A carefully planned materials recovery facility, situated within a community or municipality, serves as the hub of activities surrounding discard management. In this system, all materials are sorted into "discard categories" as a first effort in a series of steps designed to maintain or increase the value of the discarded materials entering the facility. Virtually all of the MSW is considered amenable to sorting and resale, either as products sold for reuse, or as raw materials or feedstocks for industry, construction or landscaping. Very little is considered "waste" in the conventional sense, once the necessary infrastructure has been created to handle these diverse materials as valuable resources.

Social, economic, and environmental benefits of such a comprehensive discard management system are emphasized in the effort to resolve many interrelated problems associated with our modern urban and material lives. It also implicitly views incineration with energy recovery as failing to recover anything of value. With respect to source reduction, however, this discard management approach is weak. Patterns of consumption and production remain outside this perspective.

Figure 2 illustrates the strong emphasis on recycling which characterizes this paradigm.
From Dan Knapp



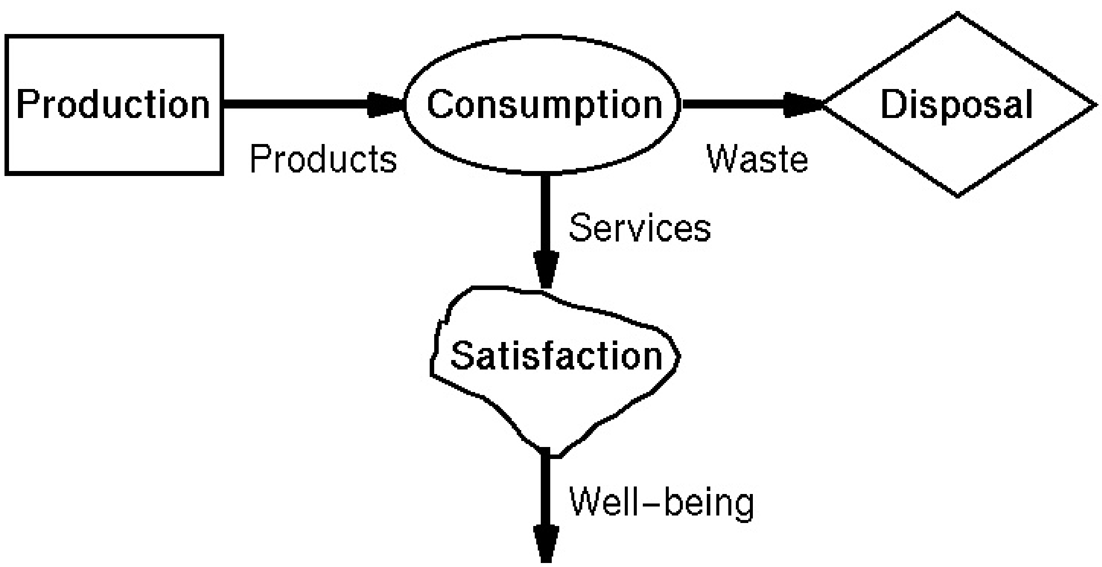
Value in Use Paradigm (VIUP)

This perspective acknowledges the need for separate approaches to distinct aspects of the movement and transformation of material goods through society. In this view, consumption is the subject of interest along with its relation to products, and the services derived from them. Other aspects such as production, and managing what is thrown away are seen as best examined separately. The core of this perspective addresses what happens when products are actually used, and how this use or consumption process sheds light on other concerns about materials in our society. Because consumption is often overlooked or not understood to be subject to change, this paradigm seeks to open up the issue to scrutiny. By gaining a better understanding of how consumption is related to the value in the physical objects that is "consumed," insights about potential ways to reduce the demand for products can be gained. The goal is to find ways to reduce the level of production necessary to sustain the services we have come to expect.

Emphasizing the product-service interface, attention is drawn to possible ways of maintaining or improving services while reducing the demand for products. Because source reduction of recyclables (in addition to landfilled material) is seen as valuable, source reduction is accorded considerable potential, far more than in the dominant paradigm. Because this approach zeroes in on consumption, insights about consumption behavior can be used to augment conventional criteria involved in deciding how and what to produce in the first place. Waste *production* management is seen as clearly distinct from waste *disposal* management, stressing the importance of tackling them as separate concerns requiring separate methods and tools.

Empirical research on all aspects of consumption is a priority. The identity of consumption and "waste production" is central to this view of waste management. Whereas in the other paradigms waste is conceptualized and defined with respect to where it *ends up*, here waste is viewed according to where it comes *from*.

Figure 3 situates consumption at the intersection of the material flows from production toward disposal. Satisfaction is thought to result from services obtained in the course of this consumption:



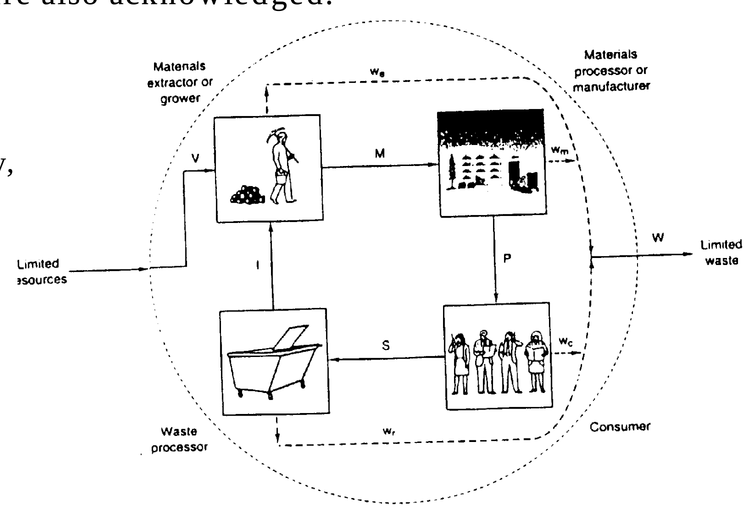
Material Flows Paradigm (MFP)

The fourth paradigm identified here draws on ideas from several closely related fields of study. The discipline of Industrial Ecology concerns itself with the significance which anthropogenic material flows have for the natural world, and also with possibilities for improving material efficiency (the efficiency of the processes by which materials are transformed into a product or service). Design for Environment is another name given to efforts to reduce the environmental burden associated with industrial production. The focus is on optimizing the total industrial materials cycle from virgin material to finished product and ultimate disposal of wastes. “Cleaner production,” “eco-efficiency” and “product life extension” all draw on the notion that current industrial economies have just begun to tap the vast potential for improving *system-wide* resource efficiency.

The firm or factory constitutes the level at which most observations pertaining to minimizing the flow of materials through our industrial societies are made. Design for source reduction and dematerialization are two strategies which parallel attempts within other paradigms to reduce the quantity of materials destined for disposal. In the MFP, recycling is generally considered an inherently superior alternative to disposal, in contrast to the more restrictive view of the VIUP, which treats recycling as coequal with disposal. Finding ways to minimize material flows in production processes is understood to be a crucial means toward achieving a more harmonious coexistence with the natural environment. Waste is thought to be avoidable through clever design of essentially all “life cycle” processes, with particular focus on stages in which materials are transformed. The degree to which the use phase is considered varies within this perspective. Some representatives focus on product utilization and durability as key variables. Others are concerned more with increasing the efficiency with which materials are transformed in earlier phases such as mining, manufacturing or transport.

With a broader material flows perspective, this paradigm takes the issue beyond waste management to a concern over material throughput (as a proxy for all relevant flows--inert, toxic or energy-related) and its relationship to quality of life. The stated goal is to optimize materials use from “cradle to reincarnation,” relying on recycling as a key metaphor. Materials are judged by the degree to which their characteristics facilitate the goals of total cyclicity. Source reduction, which is not really about cycling, does have its parallel here in dematerialization. While sustainability is touted as the desired end, the technical and engineering aspects of sustainability certainly take precedence over social and environmental concerns, even as these are also acknowledged.

Figure 4 emphasizes multiple transformative stages of materials, as well as the desirability of recycling wastes back into production: (from Graedel and Allenby: Industrial Ecology, 1995, p. 96) “The letters refer to the following mass flows: *V*, virgin material; *M*, processed material; *P*, product; *S*, salvaged material; *I*, impure material; and *W*, waste. … ”



IV. Definitions of Key Terms as They are Used in Four Paradigms

In this section we are interested in three issues:

- Terms which identify or highlight ideas central to the paradigm in question.
- Terms that are used by all or several paradigms in different ways or to mean different things. These are interesting whether or not they are key terms, in that they are interpreted differently and/or mean different things.
- Terms which have been used (in the past, or perhaps casually) by adherents of this paradigm to signify a particular concept, but do not serve to clarify its meaning and should be identified and perhaps dismissed because of the potential to confuse, or because a less ambiguous synonym exists.

Dominant Paradigm:

terms in all paradigms:

- waste (n)
- disposal
- recycling

terms in several paradigms:

- diversion
- source reduction
- residue

unique terms:

- waste reduction
- waste prevention
- Integrated Waste Management Hierarchy

Value in Use Paradigm:

terms in all paradigms:

- waste (n)
- disposal
- recycling

terms in several paradigms:

- reuse
- source reduction

unique terms:

- production
- consumption
- waste management
- waste production
- municipal solid waste (MSW)

Discard Separation Paradigm:

terms in all paradigms:

- waste (n)
- disposal
- recycling

terms in several paradigms:

- diversion
- reuse
- residue

unique terms:

- discard (n)
- waste (v)

Material Flows Paradigm:

terms in all paradigms:

- waste (n)
- disposal
- recycling

terms in several paradigms:

- reuse
- source reduction
- residue

unique terms:

- life-cycle wastes
- Industrial Ecology (IE)
- Design for Environment (DFE)
- life cycle assessment
- product life

Dominant Paradigm:

waste

"Material discarded by the generator as no longer useful to the generator."[1]

This definition is so broad as to leave open whether recyclables are included or not.

disposal

"The placement of waste in a landfill or other repository intended for permanent containment of waste. ('Incineration' is sometimes described as disposal.)"[2]
"Reuse, recycling and composting are not considered disposal."[3]

Some ambiguity exists in the use of this term, regarding exactly what it should include.

recycling

"The process of collecting, sorting, cleansing, treating, and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw material for new, *reused,*[(ACWMA)] or reconstituted products which meet the quality standards necessary to be used in the marketplace."[4]

diversion

"Diversion means to divert solid waste … from disposal at solid waste landfills or transformation facilities [incinerator] through source reduction, recycling or composting."[5]

The confusion with regard to where or how source reduction fits into the larger picture is evident in this definition. To have included source reduction here as a method for diverting solid waste shows how it is conceptualized.

source reduction

"Any action that avoids the creation of waste by reducing waste at the source, including redesigning of products or packaging so that less material is used; making voluntary or imposed behavioral changes in the use of materials; or increasing durability or re-usability of materials."[6]

"The hierarchy begins with <u>source reduction</u> and reuse to reduce both the toxic constituents in products and the generation of large quantities of waste. Source reduction… may occur through design and manufacture of products and packaging with minimum toxic content, minimum volume of material, and/or a longer useful life. Source reduction may also be practiced at the corporate or household level through selective buying habits and reuse of products and materials. …. Source reduction is not

[1] NRC: *Measurement Standards and Reporting Guidelines*, Draft, p. 18.
[2] CIWMB, 8/94:, p. 14.
[3] NRC Memorandum, 8/95, p. 4.
[4] CIWMB, 8/94.
[5] CIWMB: Attachment 2: *Key Term Definitions*.
[6] NRC: *Measurement Standards* p. 17.

used by local waste handlers for managing the waste that is picked up every day; rather, it cuts back on the amount and the toxicity of the waste which is handled. However, local government can encourage as well as practice source reduction."[7]

residue

"Materials remaining after processing, incineration, composting, or recycling have been completed. Residues are usually disposed of in landfills."[8]

This term refers to a secondary stage that follows non-landfill disposal options, in which the remaining unrecoverable portion is itself landfilled.

waste reduction

Waste reduction is sometimes used as an umbrella term to denote

all activities subsumed under **source reduction**, as well as recovery for **recycling** (including composting). Thus waste reduction is considered to include all **waste management** actions short of actual **disposal** in a landfill or incinerator.[9]

This definition does not distinguish this term from diversion. It can also be used to mean only *source reduction:*

"... only waste reduction *prevents* the generation of waste."[10]
"Reducing the amount or type of waste generated. Sometimes used synonymously with **source reduction**."[11]

waste prevention

"Any action undertaken by an individual or organization to eliminate or reduce the amount or toxicity of materials before they enter the municipal solid waste stream. This action is intended to conserve resources, promote efficiency, and reduce pollution. The CIMWB uses this term instead of **source reduction** since we have found it is easier for the public to understand."[12]

Waste prevention is used to include recycling as well.

Integrated Waste Management Hierarchy

- source reduction (including reuse of products)
- recycling of materials (including composting)
- waste combustion (with energy recovery)
- landfilling.[13]

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[7] EPA: *The Solid Waste Dilemma: An Agenda for Action*, p. 18
[8] EPA: *Decision-Makers Guide*, p. 153.
[9] EPA: *Characterization of Municipal Solid Waste in the United States, 1996 Update*: 90.
[10] OTA: *From Pollution to Prevention*, p. 34.
[11] EPA: *Decision-Makers Guide in Solid Waste Management*, p. 154.
[12] CIWMB, 8/94.
[13] EPA: *The Solid Waste Dilemma: An Agenda for Action*, p. 16.

Discard Separation Paradigm:

waste (noun)
"A discard that has been wasted. When a discard becomes waste, the option to recycle has already been foreclosed. A discard isn't waste until it's **wasted**. Also = garbage: "Garbage is not one of nature's own products. A well-capitalized industry manufactures it by routinely mixing all discards together, thus degrading them."[14]

disposal
"making discards go away. Disposal options include selling for reuse, giving to someone, recycling into new products, and **wasting** by landfilling or burning. Disposal may be free, or one may be required to pay for the service. One may dispose of banana peels or a parent's estate."[15]

recycling
"A form of disposal that uses a discard for its constituent materials. Recycling often requires a major industrial process. Composting is a form of recycling; it transforms leaves, grass, and other yard debris into humus."[16]

diversion
[see definition under Dominant Paradigm*]*

reuse
"A form of disposal that uses a discarded item again as itself. Reuse generally thrives in decentralized locations that serve local markets. "Nearly everything reusable can be scrapped, but once it has been scrapped, it is no longer reusable."[17]

residue
The unrecoverable leftover fraction of discards from which no value is retrievable. It remains after all efforts at sorting have been exhausted, i.e., = **waste**.[18]

discard (noun)
"A material that somebody wants to get out of his or her life"[19]

waste (verb)
To waste something implies foregoing all potential value by further degrading its quality--usually by throwing it away. Wasting is antithetical to recycling as it does not recognize the material value associated with the product in question.

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[14] D. Knapp: *The Bay Area's Prospects for Total Recycling*.
[15] D. Knapp, and M.L. Van Deventer, *A Recycler's Lexicon*, 1988.
[16] D. Knapp et al. 1988.
[17] Urban Ore, Inc.: *Integrated Resource Recovery Facilities*, p. 13.
[18] ibid.: Appendix A, 10.
[19] ibid., p. 13.

Value in Use Paradigm:

waste

"The 'consumption' view takes the usefulness (value) of materials as the focus, so that when most or all of this value has been lost in the course of use, a material becomes waste to the user; what value the material has to society and how it should be managed are separate from the fact of waste."[20]

"Material discarded by the generator as no longer useful to the generator."[21]

disposal

[consistent with definition under the Discard Separation Paradigm*, but without the pejorative reference to landfilling and incineration]*

recycling

"We avoid problems with definitions and accounting methods … if we acknowledge recyclables as part of the waste stream. … Recyclables are the by-products (the wastes) of some consumption process, which necessitates the expense of removal."[22]

reuse

Reuse describes a variety of different activities, which reside in the conceptual space between source reduction and recycling. Some forms of reuse are closely associated with source reduction, e.g., reuse of blank back sides of paper while others are really recycling, e.g., remanufacturing.

source reduction

[see definition under Dominant Paradigm*: also, source reduction changes how waste is produced.]*

production

Production involves a series of processes which yield, among other things, the goods we consume. It involves a transformation of raw materials and energy into final products.

consumption

The use of materials or products to deliver services. In the pursuit of satisfaction associated with the service value to be gained from consuming a product, product value is destroyed. Product value and service value both have relevance to consumption, but they are measured using different criteria.

waste management

Waste management includes two distinct processes, waste production management and waste disposal management. To deal effectively with the problems of waste, both realms must be addressed separately and in different ways. While the overall purpose is similar for both, the means for achieving this goal vary. **Source reduction, recycling**, landfilling and incineration are all examples of waste management.

[20] B. Nordman, *What is "Waste"?*

[21] NRC: *Measurement Standards and Reporting Guidelines*, Draft, p. 18.

[22] ibid., p. 16.

waste production

Waste production is another way of referring to the implications of our use of materials. It is a natural and inherent feature of our lives as human beings. In the course of economic and social activities a certain amount of unwanted matter is invariably generated. Although the amount is subject to certain influences, the fundamental reality of waste is not itself negotiable. Everything that is produced eventually becomes waste.

municipal solid waste (MSW)

"Includes residential, commercial, and institutional non-hazardous solid wastes."[23]

Definition does not include industrial waste, even though such wastes often end up in the same landfills

Material Flows Paradigm:

waste/residues

"Industrial ecology rejects the concept of waste. … In our industrial world, discarding materials wrested from the Earth System at great cost is also generally unwise. Hence materials and products that are obsolete should be termed *residues* rather than *wastes*, and it should be recognized that wastes are merely residues that our economy has not yet learned to use efficiently. … we encourage the use of the term *residues*, thereby calling attention to the societal value contained in obsolete products of all sizes and types."[24]

disposal

Disposal is defined in opposition to recycling. The extent to which the disposal option is chosen in an industrial ecology cycle is considered a measure of how recycling has either not been tried or failed. Also "waste-disposal."[25]

recycling

"Separation, recovery, processing, and reuse of obsolete products, materials, or industrial by-products."[26]

"Closed-loop recycling involves reuse of the materials to make the same product over again (sometimes called *horizontal recycling*), whereas open-loop recycling reuses materials to produce a different product (sometimes called *cascade recycling*)."[27]

"We propose that the generic term **re-use** be subdivided into three categories: <u>cascading</u>, in which a consumed material is directed to a lower quality feedstock and further consumed; <u>recirculation</u>, in which a non-consumed material is re-used indefinitely; and

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[23] NRC: *Measurement Standards and Reporting Guidelines*, Draft, p. 15.
[24] T.E. Graedel & B.R. Allenby, *Industrial Ecology*, p. 10.
[25] ibid., p. 113.
[26] Joseph Fiksel, *Design for Environment: Creating Eco-Efficient Products and Processes*, p. 501.
[27] T.E. Graedel & B.R. Allenby, p. 263.

upgrading, in which a consumed material is partially or fully returned to its pre-consumed state. For additional clarity, the upgrade category should be divided into two subcategories: partial recycling, in which the quality of a waste is increased, but the waste is not returned to its pre-
consumed state; and **recycling** in which a waste is fully returned to its pre-consumed state."[28]

These terms are applied to industrial processes here, in contrast to their more common interpretation at the household level. A variety of related but distinct processes that are otherwise lumped together either under re-use or recycling are specified, providing us with a vary narrow definition of recycling in this case.

reuse

"The additional use of a component, product, or material after it has been removed from a clearly defined product or process stage even if some cleaning or processing is required."[29]

source reduction

[see definition under Dominant Paradigm*]*

residue

[see definition under **waste**, *above]*

life-cycle wastes

"Materials and energy wastes generated during the entire life of the product/package, including both preconsumer and postconsumer wastes. Sometimes referred to as 'cradle-to-grave' wastes in the literature, these wastes stem from extraction of raw materials, manufacture, transportation, distribution, use/consumption, and **disposal**--and can be released to all media (land, air, water)."[30]

The emphasis here is on the fact that in striving for a decrease in waste, attention must be paid to all stages of the product life-cycle:

Industrial Ecology (IE)

"Industrial ecology is the study of the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural, and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized include resources, energy, and capital."[31]

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[28] L. Connelly & C. Koshland, *Two aspects of consumption*, p. 204.
[29] D.F. Ciambrone, *Environmental Life Cycle Analysis*, p. 126.
[30] World Wildlife Fund and The Conservation Foundation, *Getting at the Source*, p. 11.
[31] T.E. Graedel & B.R. Allenby, p. 9.

Design for Environment (DFE)

"DFE is essentially a design process in which environmental attributes are treated as design objectives in tandem with other conventional design goals rather than as constraints. … DFE incorporates environmental objectives with little or no loss of product performance, useful life, or functionality."[32]

life-cycle assessment

"The life-cycle assessment is an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and material usage and environmental releases, to assess the impact of those energy and material uses and releases on the environment, and to evaluate and implement opportunities to effect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation, and distribution; use / **re-use** / maintenance; **recycling**; and final **disposal**."[33]

product life

"The length of time household consumer durable goods remain in the household sector stock, or inventory (in the use for which they were primarily designed) from the time of purchase as a new item to time of final discard to either waste disposal or material recycling."[34]

This definition implies that the key variable is whether or not the product is present, and that the degree to which it may be used *is secondary.*

[32] R. van Berkel et al., The Relationship between Cleaner Production and Industrial Ecology, p. 56.
[33] ibid., p. 108.
[34] F. A. Smith: *Product Design Modifications for Resource Recovery, Source Reduction or Solid Waste Management Purposes* , p. 16.

V. Extended Discussion of Paradigms, Including Comparisons

The following discussion pays particular attention to the ways in which the different positions treat solid waste management conceptually, especially with respect to source reduction, and how language is uses. Each of the paradigms serves a purpose and it is not my intent to assert that any one paradigm is more "correct" than another, but rather to clarify how they relate.

Within the broad field of solid waste management, several schools of thought can be distinguished. If the circle is drawn to include those interests concerned with materials more generally (without explicit reference to their status as waste), we can identify even more paradigms. Broadly they are as follows:

• (1) The Dominant Paradigm: The "integrated waste management hierarchy" serves as a guiding principle, with fairly general goals, unified in the pursuit of reducing the emphasis on landfilling.

• (2) The Discard Separation Paradigm: All materials are considered potentially valuable, if the proper institutions for their recovery can be created. The focus here is on collecting and reintroducing / reselling materials that no longer fulfill their primary functions, through development of markets in which such trades can occur.

• (3) The Value in Use Paradigm: Materials are understood to be carriers of value. Here source reduction is pursued in the context of product use (or consumption).

• (4) The Material Flows Paradigm: Emphasis is placed on the need to re-design products and production processes, for the purpose of optimizing service value using the least amount of materials from cradle to grave.

All four paradigms differ in their view of which phase is most important. The four paradigms identified are concerned with successively earlier phases of material transformation, as we work our way backward from questions of how best to get rid of unwanted "waste" (DP), to options for more completely valuing "discards" (DSP), making better use of existing embodied value (VIUP), and redesigning products and processes up front for better system wide material efficiency (MFP).

Dominant Paradigm:

In the 1970s, the U.S. EPA developed what is commonly referred to as the Integrated Waste Management Hierarchy. The purpose of this hierarchy was to provide a framework for moving beyond the

> disposal-based paradigm in which garbage was viewed as one homogeneous mass that should be collected, compacted and buried or burned. The new paradigm argued that garbage was instead made up of several different components, and depending upon the physical, technical, and economic characteristics of each component, it should be handled by different types of solid waste management methods: some parts of the waste stream simply should not be generated; other parts have physical properties that make them technically and economically feasible to recycle; some parts can be composted; some can produce energy; and some parts of the waste stream can only be buried.[35]

In this pluralist view, solid waste managers are charged with developing the necessary infrastructure for collecting and processing the various components of the waste stream.

[35] Schall, 1992, p. 1.

All levels of government are called upon to implement this approach, together with the private sector and the public.

This change in policy was initiated because it was becoming apparent that "the United States must find a safe and permanent way to eliminate the gap between waste generation and available capacity in landfills, combustors, and in secondary materials markets."[36] Because of the perceived shortage of landfill capacity and high cost of managing waste, a series of complementary solutions is offered with the aim of providing direction and support to communities, cities and states scrambling to resolve their MSW crises. Although the specific interpretation of the management hierarchy varies with the organization employing it, all make reference to the general pattern set out by the EPA:

1. Source Reduction (including reuse of products and backyard composting of yard trimmings)
2. Recycling (including composting)
3. Waste Combustion (preferably with energy recovery) and Landfilling[37]

Sometimes reuse is given a separate place between source reduction and recycling, and incineration is also at times considered preferable to landfilling.

This set of management options reflects the belief that the problems associated with MSW are best addressed on several fronts. "In an integrated waste management system, each component is designed so it complements, rather than competes with, the other components in the system."[38] By listing a variety of different ways in which to approach or handle waste, this set of prioritized options aims to please all constituencies without alienating anyone. No option is categorically excluded, and all are given a role in helping to resolve the crisis. "We are all responsible for the municipal solid waste dilemma. Consequently we are all part of the solution."[39]

The rationale behind this approach is to identify options that can work at all levels of society, from the local and regional to the state. The power to decide how the management hierarchy is to be implemented is delegated to the state and local authorities, with the federal agencies providing technical support and legitimacy. The jurisdictions are encouraged to interpret the prioritized ranking according to their own particular circumstances. The relative costs of the alternatives are given much weight in determining what set of options is chosen. "Some communities and waste handlers, based on land availability and population characteristics that make recycling impractical, may choose landfilling as their principal method of managing municipal solid waste."[40] The need for a new and different approach initially arose because the cost of landfill disposal was rising dramatically in some areas and waste management authorities were ill-prepared to deal with the changes. To the extent that this situation prevails in a given community, alternatives are promoted heavily. If however, "a community like Las Vegas, Nevada, where landfill tipping fees as low as $6 per ton reflect the ready availability of land, [chooses] to continue to rely on landfilling as its primary waste management practice after evaluating the feasibility of source reduction and recycling," nothing in the EPA's approach would stand in its way.[41]

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[36] U.S. EPA 1989 [a], p. 22.
[37] U.S. EPA 1997.
[38] U.S. EPA 1989 [a], p. 17.
[39] U.S. EPA 1976, p. 2.
[40] U.S. EPA 1989 [a], p. 19.
[41] ibid., p. 16

Because the situation surrounding solid waste disposal is perceived to have been inadequately handled in the past, it is critical that "government, industries, waste managers and citizens … learn to look beyond the 'single solution' to waste problems."[42] Integrated Waste Management aims to be inclusive, and so must reject solutions that only address single issues.

Source reduction, recycling, incineration and landfilling are all important elements in an integrated waste management strategy, and everyone involved with waste management must be given the opportunity to learn about all of them. The next step is then to determine what combination of the above will work in a given locale. Because source reduction is considered to be "a relatively new and difficult practice for municipal solid waste," the EPA proceeds with caution when recommending strategies that incorporate ideas related to it.[43] Recycling, on the other hand, is a more familiar arena. The EPA holds it up as a conceptual model for understanding the larger problem of waste generation: "Recycling is an excellent educational tool to raise awareness in individuals of all types of waste management, because everyone must become conscious of what they do and do not discard."[44]

The manner in which the ideas on diversifying the management of solid waste are presented in this paradigm indicate an ambivalence about how to resolve the problem, and even about what the problem is. Although source reduction is given great prominence at the head of the list, and the EPA goes to great lengths to explain how it would function within the broader scheme, its use as a waste management tool is acknowledged to be quite limited. Because source reduction deals fundamentally with prevention rather than with conventional management of wastes, those actors who would be in a position to put source reduction into practice (primarily manufacturers and regulators, and--to a lesser degree--consumers and local governments) have little in common with those who are currently in charge of managing what has already been generated.

> If solid waste managers think about what they do as managing garbage, even in an "integrated" manner, they will not be able to implement the solid waste hierarchy, even though it makes technical, economic and environmental sense. … To implement the solid waste hierarchy, solid waste managers must participate in the larger endeavor of managing all of society's resources.[45]

Because the Hierarchy implies a break with past attempts at tackling solid waste management problems, landfilling (the "conventional" method) should be reassessed in light of the other elements of the Hierarchy so that we can live up to this challenge.

The Office of Technology Assessment (OTA) has addressed this difficulty repeatedly, pointing out that after twenty years of pollution control culture at the EPA, "waste reduction poses a major shift in thinking--a paradigm change--about how to best achieve environmental protection."[46] Emphasizing the hierarchical aspect of this approach has created confusion about the rationale and purpose of integrated waste management. In practice this management approach is characterized by a pragmatic endorsement of what are perceived to be complementary solutions to problems of waste management. The prioritization of source reduction and recycling over disposal appears to be an *a priori*

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[42] U.S. EPA 1989 [a], p. 24.
[43] ibid., p. 45.
[44] ibid., p. 49.
[45] Schall 1992, p. 71.
[46] OTA 1987, p. 37.

judgment about their relative merits, and in theory this is undoubtedly the case. "In general, the hierarchy refers to an ordered set of preferences, based on supposed levels of human health and environmental risk."[47] However, as waste management is implemented, the hierarchical element loses out to the economic and political circumstances of the moment.

To those interested in pursuing source reduction in line with the priority it seems to enjoy at these high levels, the observation that, "landfilling is expected to continue to be the single most predominant MSW management method in future years"[48] is an unwelcome concession. From the perspective of the Value in Use Paradigm, this approach lacks a substantial commitment to source reduction, and will therefore settle for token amounts of avoided waste production. In some cases, source reduction credit is given for "no net increase in waste generation"[49], and in others the goals of what will be "source reduced" are set far lower than for recycling or other methods, if any goals are set at all.[50] Source reduction is also commonly thought to be "like recycling," where backyard composting, for example, is considered to exemplify some of both. Buying items from thrift stores and reusing products are also associated with the idea of source reduction.

Because the Dominant Paradigm started out as a response to what was, and may again become, an acute problem of capacity and cost, its motivating force is limited to finding acceptable ways of "dealing with" waste. Efforts to expand the range of management options are generally in response to difficulties with existing methods, rather than anticipatory, proactive attempts to improve the social and economic fabric of communities as in the Discard Separation Paradigm.

The degree to which source reduction will be integrated into a larger management strategy depends also on whether the present focus on managing waste disposal can be stretched to include the management of waste production as well. The Value in Use Paradigm has identified this as a critical distinction which has so far proved to be a conceptual hurdle.

Being the dominant approach, the terms which characterize how the solid waste management world is structured according to this paradigm are not unfamiliar: <u>Waste reduction</u> is used as a collective--if vague--term to describe all non-disposal alternatives to problems of solid waste. Efforts have been underway within this paradigm for some time to broaden the range of options beyond variations on the idea of <u>disposal</u>--a throwing away. <u>Diversion</u> is another term used almost synonymously with waste reduction, and it too signifies the attempt to move beyond disposal to spread the burden of unwanted material over a variety of constituencies and jurisdictions. <u>Source reduction</u> is invoked a lot in this paradigm, but words are not often matched by deeds, at least on this issue. Source reduction has proven a hard nut to crack--whether for conceptual or philosophical reasons, or simply because it is inherently more difficult to operationalize than <u>recycling</u> and other strategies which manipulate existing material flows.

[47] OTA 1989, p. 301.
[48] U.S. EPA 1997, p. 3.
[49] Schall 1992, p. 35.
[50] ibid., p. 38; U.S. EPA 1997, Chapter 3.

Discard Separation Paradigm:

In this view, the problem is seen not so much as one of capacity and cost, but of institutionalized wastefulness. Instead of conceptualizing what we wish to get rid of as "waste," this perspective emphasizes the latent value of the materials by referring to them as "discards," a term denoting the act of relinquishing ownership, distinct from an assertion of valuelessness. Landfills are considered an obsolete and inefficient way of dealing with what are in fact valuable resources. "Garbage is not one of nature's own products. A well-capitalized industry manufactures it by routinely mixing all discards together, thus degrading them."[51] A comprehensive recycling system capable of processing all but a small portion of the stream of discards is offered instead. Proponents of this approach argue that with the requisite infrastructure, organization and markets such a system can render landfilling all but unnecessary; strengthen the local economy; provide high quality materials, feedstocks, and products to the community and to industry, while contributing significantly to conservation of resources and pollution prevention. The process of getting to that point, however, is not made easier by existing institutions and price structures. In order for this process to be successful, a variety of relationships must be established and maintained; between public and private organizations, between buyers and sellers, and within the community, which will ultimately be relied upon to supply and purchase a large portion of the materials handled.

The first step toward developing such a material recovery facility is the categorization of the things we throw away. By looking at the relative proportions of different materials found in MSW and dividing them into master discard categories it becomes possible to design a facility for dealing with the totality of our refuse. The processes, organization and facilities necessary to put into practice such an enterprise are shaped by--and are a function of--the current market prices for secondary raw materials (or market value for reusable goods.) Within this context, the attempt is made to ensure that the materials handled retain as much of their value as possible.

Diverting the majority of what we throw away from becoming waste requires a broad understanding of how secondary materials can be reintegrated into the production sphere. To facilitate this strategy of maintaining value, discarded materials must be separated and then classified, processed and upgraded to be sold once again as raw materials or feedstocks. With products that are sold for reuse the situation is very similar--the demand for these goods must be identified and carefully matched with a supply of reconditioned, functioning products. The slightly lower value, by weight, of these materials and products makes long-distance transport uninteresting; therefore this approach will tend to be tied to a particular locale. Developing the requisite facilities, infrastructure and markets comprises a large portion of the effort involved.

The goal is to facilitate the sale of as much of the materials, that would otherwise be landfilled or incinerated, as possible. Working largely within the existing price structure, and without addressing production and use, this approach targets the stream of materials and products destined for the garbage heap. By providing the infrastructure for capturing the often rather low per-unit value of these materials and products, and benefiting from certain economies of scale, such a facility can become financially self-supporting.

By competing with refuse facilities, both for the supply of materials *and the tipping fees*, a materials recovery facility provides both an economic and an environmentally

[51] Knapp 1990.

interesting alternative to traditional methods of disposing of waste.[52] Theory and practice are more difficult to separate out in this paradigm, for obvious reasons. While its scope is narrower than in the two remaining approaches, the Discard Separation Paradigm nevertheless appears to have identified practical methods for integrating a variety of different aspects and concerns associated with the management of solid waste.

The terms which characterize how the solid waste management world is structured according to the Discard Separation Paradigm follow briefly: Discards and scrap are the bread and butter of this Paradigm. They refer to the quantities of obsolete or unwanted materials or products which are considered, in this view, to be too valuable to waste (v). Recycling is the process, and waste (n) is what is strenuously avoided.

Value in Use Paradigm:

What is of interest here has less to do with waste management, conceptualized as strategies for disposal, and more with the relationship between material goods and consumption. A linear flow of material from the initial extraction of raw materials, via manufacture, transport, production, use and disposal is taken as given. Within this general pattern, however, the Value in Use perspective describes how materials and products are transformed into services. At one level removed, the process of satisfaction in turn transforms services into well-being. These relationships are not of interest to the other paradigms, as they instead focus on issues either before--or usually after--the product has ceased to provide services. Because so little is known about how consumption and the stream of products which sustain it are related, this perspective seeks to determine what can be learned from a more complete understanding of the phase between purchase and disposal.

What happens after a product is purchased is usually omitted entirely from any analysis. In the dominant paradigm, only source reduction touches on aspects related to use. To those interested in discard management, what happens before something is discarded isn't of particular concern, either. What we have termed the fourth paradigm here embodies an ambivalent view of the importance of understanding use and consumption. Some representatives of this perspective are interested in what they refer to as the "utilization period;"[53] while others gloss over or ignore it. Generally, though, consumption is understood to be too messy a realm to bother with. Attention is focused instead on more easily quantifiable phases of materials transformation.

This perceived difficulty of measuring what goes on during use has contributed to our lack of understanding of it. The quantity of material objects we "consume" has obviously risen steadily, in step with economic growth, and the equation of "standard of living" with "level of consumption" helps explain our willingness to endorse this trend. In the United States and other industrialized countries, physical throughput, GDP, and consumption are all increasing, and much more rapidly than is population growth[*]. Yet it is not at all clear to what extent these variables positively effect human satisfaction or well-being. Some argue that efforts to satisfy our desires through economic production and

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[52] Urban Ore, Inc. 1995, p.23.

[53] Giarini & Stahel 1993, p. 69.

[*] Actually aggregate MSW production decreased slightly in 1995, the last year for which statistics are available, and the first year in recent memory in which economic prosperity was accompanied by a decrease in MSW.

consumption of goods and services actually interferes with our ability to satisfy more basic needs.[54] To others, the level of material throughput involved in the current economic system can no longer be morally justified. In either case it is argued that it will be necessary to define how use (consumption) relate to both the products generated by the economy as well as to the satisfaction of human needs and aspirations.

Bruce Nordman, a leading advocate of the Value in Use Paradigm, argues that in trying to address the subject of consumption it would be best to develop separate tools and methods in both the scientific and policy arenas. "A consumption-based perspective should be used in addition to, not instead of, other explanations, as it does not deny their usefulness."[55] A pluralist approach to studying aspects of material transformation permits a more detailed, dispassionate analysis of the various stages involved. While these stages are distinct in some respects, lessons drawn from them individually can be applied usefully toward improving the entire process. A thorough knowledge of consumption and use, for instance, can facilitate the design of a product in numerous ways, particularly when such a (re-)design is undertaken for the purpose of minimizing the use of materials or energy. Understanding what it is consumers do with the products they purchase, and how such patterns mesh with the larger material conditions of our production systems has the potential for resolving what are perceived to be poorly matched, if not downright inefficient patterns of production and consumption.

We will briefly revisit the terms which characterize how the solid waste management world is structured according to the Value in Use Paradigm: Waste production management should be distinguished from waste disposal management. Understanding the need for both as well as their differences will advance our ability to implement source reduction strategies, worthy of the name. Production and consumption are tightly linked to our production of waste, and our goal should be to find a balance between all three.

Material Flows Paradigm:

The material flows paradigm is a fairly recent set of ideas. Because the ways in which our presence impacts the integrity of the earth's biological systems are inseparable from our industrial and economic activity, this perspective is conceived as a comprehensive effort to redress the imbalance. Going beyond an examination of waste and how we might dispose of it more thoughtfully, this view is concerned with all material transformations currently associated with our efforts to satisfy our demand for goods and services. Because the scale of human economic activity has grown so large relative to naturally occurring flows of materials, a concern for waste, without reference to the activities which help to produce it, is seen as inadequate.

Several schools of thought have arisen in recent years that seek to address these issues. Industrial Ecology is the best-known discipline among these, and serves as an umbrella for many of the ideas described below. The basic premise is that industrial systems should be viewed as ecosystems: as entities that can--and should--be linked materially in such a way that effluents, or waste, is minimized, and the cycling of materials maximized. More specifically, it is thought desirable to optimize, if not actually close,

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[54] Kamenetzky 1992, p. 182.

[55] Nordman 1995, *Celebrating Consumption*, p. 8.

materials cycles in order to (drastically) reduce linear material throughput in the economy. Waste is a concept that pervades these discussions. It symbolizes the inefficiencies throughout a product's life cycle, and much work goes into devising better methods for eliminating it as far as possible. While the primary focus is on manufacturing, all stages at which material transformations occur are considered worth examining.

In the Industrial Ecology literature, considerable attention is paid to examples of how the waste of one industrial process can be used as a feedstock for another. In this manner virgin materials use can be reduced, and the need to dispose of wastes decreases accordingly, or is at least deferred. These material linkages between different firms are held up as models for reconfiguring industrial processes. The metaphor of an industrial ecosystem is used to describe these systems in which the goal of increasing efficiency is extended to materials and energy. As Hardin Tibbs put it, "our challenge now is to engineer industrial infrastructures that are good ecological citizens so that the scale of industrial activity can continue to increase to meet international demand without running into environmental constraints."[56]

Because Industrial Ecology involves a fairly recent set of ideas, the tools and methods necessary for achieving those ends it has identified are still in their infancy. Life Cycle Assessment (LCA) is a methodology that predates Industrial Ecology but targets a similar set of issues: evaluating the entire life cycle of a product with respect to its impact on a set of--usually environmental--criteria. More specifically, SETAC, the Society for Environmental Toxicology and Chemistry, has outlined a standard methodology for LCAs, arranged as follows:

- Develop an <u>inventory</u> of the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment
- Assess the <u>impact</u> of those energy and materials uses and releases on the environment
- Evaluate and implement opportunities to effect environmental <u>improvements</u>[57]

The Life Cycle Inventory stage has been adopted by many companies, while the second and third stages have proven more difficult to carry out. While LCA procedures are being continually refined, the basic idea is relatively straightforward: to gain a clearer understanding of how human activities impact the environment and to derive insights about how to minimize either the activities or the effects, depending on the nature of the situation. The idea of optimizing the ratio of economic benefit and environmental cost underlies much of what is considered to be the goal of Life Cycle Assessment. Social effects and economic considerations are not at issue, but ecological health, human health and resource depletion are.[58]

The terms which characterize how the solid waste management world is structured according to the Material Flows Paradigm are as follows: The world of <u>industrial production</u> is characterized by unnecessarily high levels of <u>waste</u>. The potential for saving energy and materials is vast and largely untapped. As in the Discard Separation Paradigm, waste is seen as, among other things, a measure of our ignorance or carelessness with regard to how we treat (in the case of the DSP, the natural world and our communities) and in the case of the MFP, the sources and sinks which industrial production relies on so

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[56] Tibbs 1991, p. 4.
[57] Fiksel 1996, p. 117.
[58] Fava et al. 1993, p. 5.

heavily. Life Cycle Assessment is exemplary of the kind of tools which can facilitate a better understanding of these relationships between demand for goods and services and the material realities which presently undergird their supply. Recycling is also the metaphor which motivates those involved in Industrial Ecology research. The cycling it implies is invoked more than any other notion as at least a partial answer to questions of how to operationalize these ideas.

VI. Concluding Remarks

Recommendations on terminology

- For both **waste** and **disposal**, the meanings are so intractably different between paradigms that a qualification or explanation should always accompany use of the term. If using the term waste, it should always be clear whether recyclables and/or non-MSW are included.
- The term **waste reduction** should be avoided, it serves no purpose.
- **Discard**, **diversion** and **source reduction** can be used without qualification, although the useful life of these terms may be limited.
- At one time or another **recycling** has been used to denote almost every conceivable solid waste management strategy short of landfilling. Its use is therefore invariably problematic. Our concern is whether a recycled material is, or is not, considered waste.
- To avoid confusion, **waste prevention** should be used only to refer to **source reduction**, and not to **recycling**.

The challenge of source reduction

As one of the goals of this paper is to envision a world where source reduction is much more actively pursued, we need to be clear about what each paradigm can be expected to contribute. A brief summary of each perspective follows:

The Dominant Paradigm recognizes the importance of source reduction, but lacks either the initiative or the necessary mechanisms to make it happen--or both. Without explicit prioritization, source reduction seems to lose out to the “easier” and more familiar methods of waste management that are inherently less complex to execute and for which progress is sometimes easier to measure.

The Discard Separation Paradigm does not address source reduction, but its advocacy of product reuse can be seen as a contribution to it.

The Value in Use Paradigm argues for a multi-track approach to source reduction in which different participating constituencies are all able to contribute in particular ways. The emphasis, however, is on the potential and need for consumers to rethink and adjust their patterns of behavior vis-a-vis the products they buy and use and the services they demand. Yet the important role to be played by design, production and marketing is not slighted either. This view identifies the need for a variety of complementary strategies.

Like the DSP, the Material Flows Paradigm subscribes very heavily to the concept of recycling. In some respects this emphasis comes at a cost to source reduction efforts. However, to the extent that design and manufacturing procedures are reconfigured with longer product life or upgradability in mind, this paradigm should be considered in support of source reduction.

Conclusion

We began this project to gain a better understanding of the motivations and preconceptions which shape different views of solid waste management. We set out to identify possible opportunities for source reduction, to create some order among the terms used to describe key concepts and relationships within the field, and to outline possible uses of these findings.

We found very little agreement on what the objectives in solid waste management should be. The usefulness of key terms depends on their having shared meanings. However the same key terms signify widely divergent ideas. The term "waste," for example, embodies rather contrary meanings. To some it represents the quintessential sloppiness they associate with traditional solid waste management while to others it is a factual description of the inevitable results of human activity. Still others think of waste simply as municipal solid waste, but seek to minimize or eliminate it. Whether recyclables are waste varies and is often unclear. Several common terms do not appear to advance our understanding and should be avoided altogether.

Source reduction, as a method of curtailing the *production* of waste, is generally not well integrated within most of the frameworks. An unfamiliarity with its demands seems to preclude any sincere attempt to implement it. Although source reduction can claim both a constituency as well as the beginnings of a set of operationalizing procedures, when compared to the highly visible efforts to institutionalize recycling, source reduction is still seeking a place at the waste management table.

Source reduction only has a significant future if the production of municipal solid waste is appreciated as a complex social, cultural and economic phenomenon. All paradigms provide insights into some aspect of source reduction, even if only to illustrate how difficult it can be to implement. However, it seems that reducing MSW *at its source* is only of primary concern to the Value in Use and Material Flows Paradigms.

All but the Value in Use Paradigm are enamored with the concept of cycling materials. While this is almost always an improvement over throwing products and materials into a landfill, it should not be confused with the very different concept of maintaining a stock of goods or products in working order over (long periods of) time. This focus on *product* quality and durability is very different from attempts to obtain pure streams of *materials*, such as occurs in the context of recycling. Both strategies aim to extend the phase during which value is maintained, but they differ with respect to the kind of value at issue.

These differences reflect the complex nature of the problem, as well as the variety of methods necessary to advance the overall goal. All methods can contribute to reducing the movement of materials and of waste destined for the landfill, but the processes and infrastructure required for each strategy are fundamentally different, as are the potential savings that can be expected from these efforts. While the paradigms are basically complementary, the confusion surrounding several key terms as well as the disputed potential of source reduction interferes with a successful implementation of the pluralist approach which the Dominant Paradigm claims to advocate.

Although the many goals and concerns can be phrased in language that would make them appear irreconcilable, this seems to us neither necessary nor helpful. If they were instead understood as complementary perspectives with different strengths and blind spots these paradigms could contribute to a more comprehensive and mature set of methods and concepts with which to tackle the formidable challenge of solid waste management.

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